Nowcasting world GDP and trade using global indicators

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- Global activity is a key driver of UK economic growth. Official estimates of world GDP and trade are only available with a lag, but more timely global indicators can give an early steer on growth.
- Global indicators have been useful in predicting large swings in world activity and have been particularly helpful since the onset of the financial crisis.
- A combination of these indicators has performed much better at tracking world GDP and trade growth since 2008 than a simple benchmark model. The global manufacturing PMI export orders index has been the single best indicator during this period.

Overview

The pace of global growth is a key determinant of economic activity in the United Kingdom. World growth affects the United Kingdom through a number of channels, including the demand for UK exports, consumer and business confidence and via the performance of financial markets.

It is therefore important for the Monetary Policy Committee to monitor changes in global demand. Official data for world GDP and trade growth are only available with a lag. But more timely indicators — such as surveys of firms or financial market indicators — can be used to track developments in global activity in real time. These indicators can be used to form a nowcast, or a best guess, of the current pace of quarterly growth of world GDP and trade before the official estimates of the data become available.

The usefulness of indicators varies over time

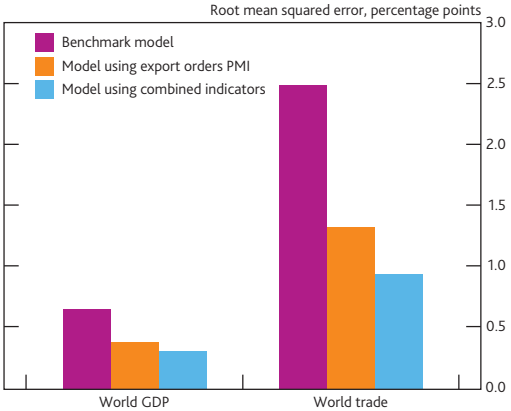
There are several global indicators available that have a high correlation with world activity and can be used to nowcast world trade and world GDP. The strength of the signal from the indicators does, however, vary a lot over time.

Between 1999 and 2007, when global growth was relatively stable, these indicators were less helpful in tracking changes in global economic growth. This is because it was difficult to predict small movements in activity. But the indicators have been more helpful during periods of large swings in world growth, as seen since the onset of the financial crisis in 2008.

The indicators were helpful during the financial crisis

This article presents analysis of the best methods for nowcasting world GDP and trade growth since 2008. Compared to a simple benchmark model, indicators have been useful in predicting the sharp falls in global activity in 2008 and the pace of the recovery since. On average, between 2008 and 2012, models that combine a number of these indicators have had the best nowcasting performance (see **summary chart** below). Since 2010, however, models based on just the export orders index from JPMorgan's global manufacturing PMI have produced the smallest errors.

Summary chart Errors from selected world GDP and world trade models since 2008



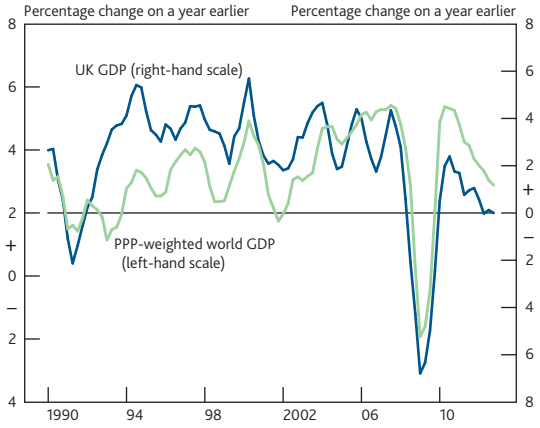
Note: Average nowcasting errors for quarterly growth rates between 2008 Q1 and 2012 Q4.

Sources: CPB Netherlands Bureau for Economic Policy Analysis, IMF, OECD, ONS, S&P indices, Thomson Reuters Datastream and Bank calculations.

(1) The author would like to thank Shiv Chowla for his help in producing this article.

The United Kingdom is a small open economy, so the pace of growth in the world economy is an important driver of UK activity. For example, as set out in the August 2013 *Inflation Report*, the assumption that growth in the rest of the world recovers is a key judgement underlying the Monetary Policy Committee's (MPC's) projections for UK growth and inflation. Most directly, changes in global growth alter the demand for UK-produced goods and services, affecting UK export growth. But other channels, such as confidence effects and financial interlinkages, are also important. Because of this, GDP growth in the United Kingdom has been highly correlated with world GDP growth (**Chart 1**), illustrating the importance of monitoring global developments closely.

Chart 1 UK and world GDP growth[a]



Sources: IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) World GDP is constructed using data for the real GDP growth rates of 144 countries weighted according to their shares in world GDP using the IMF's purchasing power parity (PPP) weights. Data are shown up to the end of 2012.

It is useful for policymakers to form a view on the current pace of world growth, as this can contain important information about how the world economy is evolving. But official estimates of world growth are only available with a delay. For example, initial estimates of GDP growth in the first quarter of the year are not available for many countries until May. So until that point, other indicators have to be used to provide an early steer on what may be happening to world activity.

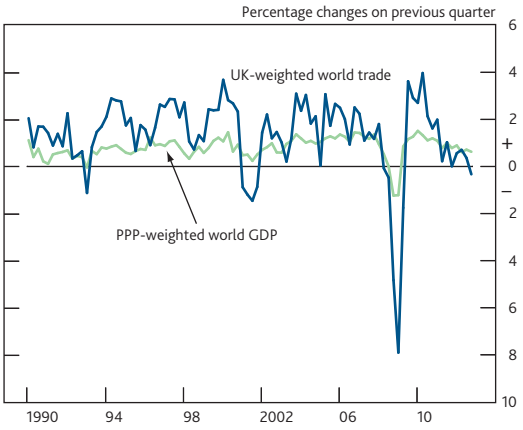
This article begins by setting out the merits of getting an early read on global activity. The article then identifies which global indicators are available and which are most useful for forming a view on world activity. The final section assesses the nowcasting performance of models that include global indicators since the start of the financial crisis.

Why nowcast world activity?

There are two aspects of global activity that are particularly important for the MPC. The first is world trade, which in this article is calculated as the growth rate of imports in the United Kingdom's main trading partners. This captures how rapidly the United Kingdom's export market is expanding, which is an important driver of UK export growth. The second key variable is world GDP. This is closely related to world trade, as stronger income will tend to boost demand for imported goods. But changes in world GDP growth also affect the UK economy through other channels. For example, changes in global confidence and economic uncertainty can spill over to affect UK spending decisions.(1) And weaker global GDP growth could reduce global asset prices and raise banks' funding costs, which may decrease domestic credit and output growth.

The growth rates of PPP-weighted world GDP(2) and UK-weighted world trade usually move closely together although, typically, world trade tends to grow more rapidly and is more volatile than world GDP (**Chart 2**).(3) The measure of world trade considered in this article weights each country according to its share in UK exports. Generally, this places more weight on advanced economies, like the euro area and the United States, than PPP weights do, as these economies are the United Kingdom's main trading partners.

Chart 2 World GDP and world trade growth[a][b]



Sources: IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) World trade is constructed using data for import volumes of 143 countries weighted according to their shares in UK exports.
(b) World GDP is constructed using data for the real GDP growth rates of 144 countries weighted according to their shares in world GDP using the IMF's PPP weights. Data are shown up to the end of 2012.

As official world GDP and trade data are published with a delay, more timely indicators can be used to construct a best guess of the current pace of global activity growth. These so-called 'nowcasts' can inform forecasts for macroeconomic variables over the near to medium term and, therefore, the stance of monetary policy today. Nowcasting is especially

(1) For more information on the impact of macroeconomic uncertainty on economic activity in the United Kingdom, see Haddow *et al* (2013).
(2) The PPP-weighted world GDP series uses purchasing power parity exchange rates from the IMF to weight together GDP in different countries. These exchange rates show the rate at which currency from one country must be converted to another currency in order to purchase the same basket of goods in both countries. For more information, see Callen (2012).
(3) For more information on the relationship between world trade and world GDP, see Domit and Shakir (2010).

important when there are large shocks hitting the world economy, as this can give an early steer on how large the real-economy impacts of such shocks are likely to be. And understanding international developments can help when interpreting UK data.

To generate a nowcast, it is necessary to decide which indicators contain the most information. In addition, since the indicators are released at different points throughout the quarter, the information that is available is constantly changing. As a result, it may be preferable to use different models depending upon what data are available at each stage of the quarter. Subsequent sections of this article explain how this can be done.

What global indicators are available?

There are two main approaches to monitoring developments in world GDP and trade. One option is to construct different models for each individual country or region and then aggregate these to form a 'bottom-up' view of global activity. Alternatively, global indicators can be used to look at world GDP and trade directly. The focus of this article is on the latter, 'top-down' method. But in practice, both of these approaches are used when forming a view and judgement will be applied to the predictions of any mechanical models.

A wide range of global indicators can be used. Some of those indicators are directly related to global growth. For example, some surveys ask firms across the world what has happened to their output or how their assessment of the current economic outlook has changed. And monthly data on global goods trade are also available. But there are also a number of indirect measures that can track developments in global activity. For example, commodity prices will in part reflect market-specific factors, such as supply disruptions, but can also provide a steer on global demand growth. A full list of the indicators considered in this article is shown in Appendix A.

Which indicators are most useful in tracking changes in global growth?

This section begins by looking at simple correlations of the various global indicators with the growth rates of world GDP and world trade. It then discusses three factors that are important when assessing the indicators' usefulness in tracking world activity. These are:

- how timely the indicators are;
- how well they track global growth over time; and
- how best the indicators can be combined.

This sets up the framework for testing the real-time nowcasting performance of some simple models based on the global indicators, which is covered in the final section of the article.

An indicator's correlation with world activity provides a steer on how useful it is likely to be for nowcasting. **Table A** shows the correlations of the various indicators with world GDP and trade. As expected, the 'direct' measures, which are most closely related to world activity, have higher correlations. In particular, the manufacturing export orders PMI and the CPB goods trade series have a very high correlation with both world GDP and trade.(1) The latter is not surprising as the CPB series is based on official monthly data that feed into the quarterly national accounts estimates of trade for each country. In contrast, the indicators that are only indirectly related to world activity generally have lower correlations. For example, the Baltic Dry Index(2) and agricultural commodity prices do not move very closely with global growth.

Table A Correlation of global indicators with quarterly growth rates of world GDP and world trade[a]

	Correlation with:	
Indicator	PPP-weighted world GDP	UK-weighted world trade
'Direct' indicators		
JPMorgan global manufacturing PMI — export orders index	0.91	0.91
CPB world goods trade[b]	0.86	0.95
JPMorgan global composite PMI — output index	0.83	0.84
OECD composite leading indicator	0.81	0.76
IFO World Economic Climate survey	0.73	0.76
'Indirect' indicators		
IATA air freight data[b]	0.72	0.77
Suez Canal traffic (tons)[b][c]	0.68	0.73
S&P GSCI industrial metals price index[b][c]	0.67	0.58
S&P global 1200 stock price index[b][c]	0.66	0.49
Brent oil price[b][c]	0.60	0.57
S&P GSCI agricultural and livestock price index[b][c]	0.50	0.34
Baltic Dry Index[b][c]	0.28	0.11

Sources: Bloomberg, CESifo Group Munich, CPB Netherlands Bureau for Economic Policy Analysis, IMF, International Air Transport Association, OECD, ONS, S&P indices, Thomson Reuters Datastream and Bank calculations.

(a) The sample period is 2000–12.
(b) Quarterly growth rates of these indicators are used when calculating the correlations above and throughout the rest of the article.
(c) Seasonally adjusted by Bank staff.

How timely are the various indicators?

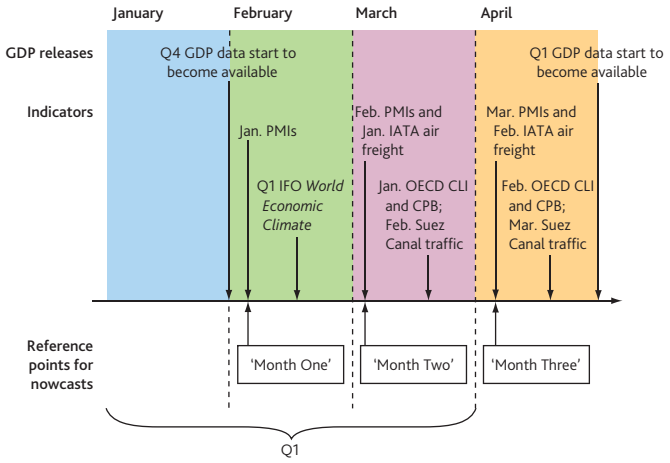
A key consideration when assessing the usefulness of an indicator is how early in the quarter it is able to provide a good steer on developments in global activity. Earlier in the quarter, only partial data are available for many of the indicators. So

(1) PMI stands for Purchasing Managers' Index. This is a survey of business activity that is conducted in a number of countries throughout the world. JPMorgan compile the monthly surveys from a number of countries to form a global aggregate. More information on these surveys and the exact questions asked can be found in Appendix A.
(2) The Baltic Dry Index is a commonly used measure of shipping costs. Shipping costs are used as an indicator of global demand in several academic papers, including Kilian (2009), as global demand is thought to be the biggest driver of shipping costs given that the supply curve is relatively inelastic in the short run. But shipping costs can be very volatile and movements do not always coincide with swings in global growth.

the correlations shown in **Table A**, which are based *ex post* on the full quarter's worth of data, are likely to flatter the strength of the signal that the indicators would give when used in real time, especially early in the quarter.

To illustrate the issue of timeliness, **Figure 1** shows when various data are released throughout the course of a typical quarter, using Q1 as an example. The timeliest indicators are daily asset prices and the monthly PMI indices. The OECD's composite leading indicator and the CPB global trade data are released with a lag of around six weeks. That means that if forming a view on Q1 growth in early February (the point labelled Month One nowcast in **Figure 1**), say, one month's PMI data will be available as well as the daily financial markets data. But there will be no data for the current quarter for any of the less timely indicators.

Figure 1 Illustrative release dates for various indicators for the first quarter(a)

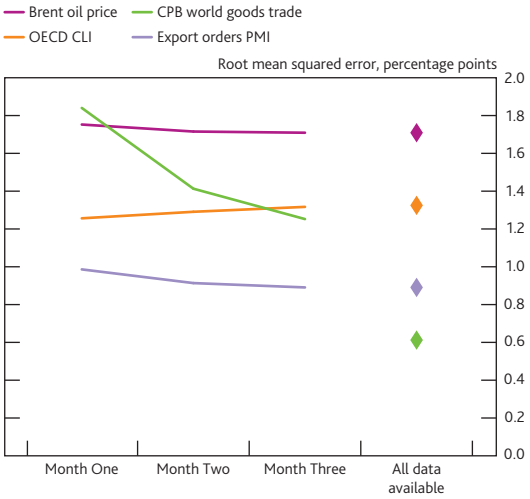


(a) See Appendix A for a full description of the indicators.

To assess their usefulness it is necessary to look at the signal each indicator gives based on data that would be available at the time. One method that can be used to do this is known as a bridge equation,(1) which involves making forecasts for missing monthly data.(2) Quarterly averages of hard data (for the months where it is assumed to be available) and forecasts for the indicator can then be mapped to the growth rates of world trade and GDP using regressions. The in-sample errors for each of the indicators at different stages in the quarter can then be compared to get a sense of how useful the data are in real time.(3) This could be done at any stage of the quarter, but throughout this article three different points in time are considered. These are around one, two and three months after the start of the quarter, specifically the point at which the preceding month's PMIs are available. These are marked as Month One, Month Two and Month Three in **Figure 1**.

For most of the indicators, there is very little change in the strength of the signal as more data become available. This can be tested by estimating simple equations that map each indicator into world trade growth. Doing this exercise, we find that the errors from the export orders PMI, for example, are only slightly smaller when all three months of data are available rather than just one month (**Chart 3** shows the errors from selected indicators). And this means that these indicators can give a useful steer on global growth even early in the quarter. However, for the CPB world goods trade data, there is a much greater improvement in accuracy throughout the course of the quarter. When the full set of monthly data is available, this indicator moves more closely with world trade than any of the others. But for the first two months of the quarter, the signal is a lot weaker as no data for the current quarter are available. This indicator is, therefore, less useful in real time than the simple *ex-post* correlations in **Table A** would suggest.(4)

Chart 3 Errors from various world trade equations at different stages of the data cycle(a)



Sources: Bloomberg, CPB Netherlands Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) The equations used are of the form: $World\ trade_t = \alpha + \beta X\ indicator_t$, where world trade refers to the quarterly growth rate and the indicators are based on data for the months where data is assumed to be available and forecasts for missing months (see footnote 2 below). The regression coefficients are estimated using ordinary least squares estimation over the period 1998 Q1 to 2012 Q4 and are calculated using the full set of data for each indicator. The errors are calculated over the same period.

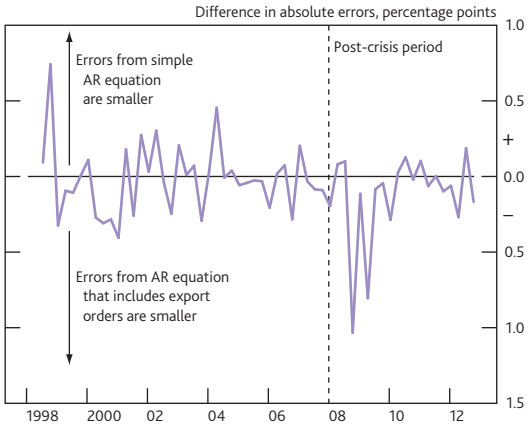
(1) For example, see Rossiter (2010).
(2) Missing monthly data are projected forward using simple assumptions that generally fit the data best. Missing data for the PMI indices and the OECD's composite leading indicator (CLI) are estimated using a simple autoregressive model. Missing data for the CPB goods trade series are assumed to grow at their historical average monthly growth rates. For all other series, data for missing months are assumed to remain at the same level as the latest data point.
(3) This exercise looks at in-sample errors from the models. To examine real-time nowcasting performance properly, only data that would have been available at the time should be used and the coefficients should also be estimated using only data available up to that point in time. Such an exercise is discussed in the final section of this article.
(4) Revisions to the indicators and world activity data are also an important consideration when thinking about real-time performance. Some of the indicators, such as the CPB and IATA data, do get revised as more information becomes available. But this does not notably affect their performance relative to other indicators. And revisions to world GDP and trade data do not materially affect the size of the errors.

How well do the indicators track world activity and how has this varied over time?

To examine how much information the indicators contain, benchmark models of world activity are needed against which models incorporating the indicators can be compared. A natural comparator is the in-sample fit from an autoregressive (AR) model.(1) This is a simple model that predicts world GDP (or trade) growth based on its past growth rates. Such models are frequently used for producing short-run forecasts and tend to perform well. In fact, it is often difficult even for fairly complex models to significantly outperform a simple AR model over short time horizons.(2) To test whether that is the case for world activity, the current period's value of an indicator can be included in an AR model as an additional explanatory variable.

Doing this exercise shows that since the onset of the financial crisis, the indicator models have performed better than the simple AR benchmark. Before 2008, however, when growth was fairly stable, the predictive power of the indicators over and above a simple AR model was fairly low. Even the export orders PMI — the indicator found to have the closest fit to world GDP growth — only improves the in-sample fit very slightly over this period (**Chart 4**). But throughout the crisis, using the export survey indicator led to a much greater improvement in the model fit, with the errors from the export orders equation 0.13 percentage points lower than the average errors from the simple AR equation over the 2008–12 period.

Chart 4 Difference in errors between the simple AR benchmark for world GDP and a model that includes the PMI indicator(a)

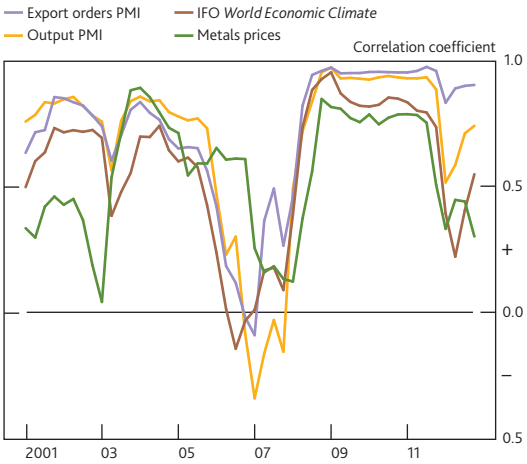


Sources: IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) The equation for the simple AR model is:
$GDP_t = \alpha + \beta_1 GDP_{t-1} + \beta_2 GDP_{t-2} + error_t^{simple\ AR}$.
And the AR including export orders model is estimated as:
$GDP_t = \alpha + \beta_1 GDP_{t-1} + \beta_2\ export\ orders_t + error_t^{export\ orders}$.
The chart shows the difference in the errors of the two models, ie $error_t^{export\ orders} - error_t^{simple\ AR}$. The errors from the export orders equation are shown for the Month Three nowcast, when the full quarter of PMI data are available. The PMI export orders indicator is shown here as this performs better than the other indicators in the third month. Both equations are estimated over available data from 1998 Q1 to 2012 Q4 using ordinary least squares.

The information content of all of the indicators has fluctuated greatly over time. That can be seen clearly in **Chart 5**, which shows rolling three-year correlations of selected indicators with world GDP growth. The indicators all moved very closely with activity throughout the crisis, when growth fell and then recovered sharply. But prior to then, the correlation was much lower, as smaller moves in indicators did not always correspond to movements in world growth.(3) For this reason, it may be best not to place too much weight on small moves in the indicators, since the signal can be quite noisy. And it is important to recognise that there is a great deal of uncertainty when interpreting movements in the indicators.

Chart 5 Rolling three-year correlation of various global indicators with world GDP growth(a)



Sources: CESifo Group Munich, IMF, OECD, ONS, S&P indices, Thomson Reuters Datastream and Bank calculations.

(a) The correlations shown here are based on using the full quarter of data for each of the indicators.

Combining the signal from multiple indicators

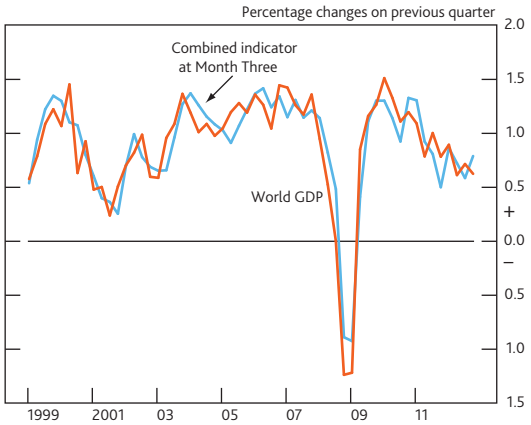
There is long-standing evidence in the literature suggesting that combinations of forecasts can outperform individual models.(4) So even though the world export orders index outperformed the other indicators in the past for both world GDP and world trade, it may be possible to improve the accuracy of the nowcasts by placing some weight on alternative indicators. A reason for this is that the errors from the different indicators may be offsetting. And given that every indicator can give a misleading signal from time to time, more confidence may be taken from a signal if it is supported by alternative indicators.

Charts 6 and **7** show the in-sample estimates from combined indicator models for world trade and world GDP. The combined indicator models are constructed by using a regression to determine how much weight should be placed on the steer from the various indicators at different points in the quarter. This method selects the combination of indicators

(1) See Hamilton (1994).
(2) See, for example, Mitchell (2009), which notes the usefulness of an AR model as a benchmark when nowcasting UK GDP.
(3) This feature is also present when looking at indicators of UK activity, where surveys of output are generally found to be a good indicator of larger movements in output, but less helpful for tracking small changes in growth. For example, see Wheeler (2010).
(4) See, for example, Bates and Granger (1969).

that has the best fit with world activity over the past. More information on these models and the indicators that are included in each model can be found in Appendix B.

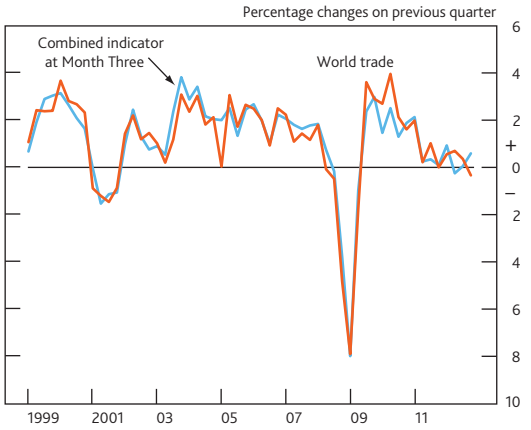
Chart 6 Combined indicator model of world GDP (in-sample fit)(a)



Sources: IMF, OECD, ONS, S&P indices, Thomson Reuters Datastream and Bank calculations.

(a) The regression model at Month Three weights together nowcasts that are generated using the manufacturing PMI export orders index, the OECD's composite leading indicator and metals prices. The equations are estimated between 1998 Q3 and 2012 Q4 using ordinary least squares. For more information see Appendix B.

Chart 7 Combined indicator model of world trade (in-sample fit)(a)



Sources: CPB Netherlands Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) The regression model at Month Three weights together nowcasts that are generated using the manufacturing PMI export orders index, the composite PMI output index and the CPB world goods trade data. The equations are estimated between 1998 Q3 and 2012 Q4 using ordinary least squares. For more information see Appendix B.

Using the range of indicators leads to an improvement in accuracy relative to using just one indicator: on average, the in-sample errors for world GDP are around 10% smaller than those based on the model that only uses the export orders PMI. And for world trade, the combined indicator model errors are around 20% to 30% smaller than those based on the single indicator.

Testing the nowcasting performance of the indicators throughout the crisis

This section focuses on the nowcasting performance of the indicator models since 2008. In particular, it assesses which indicators gave the best early warning that growth was slowing and how well they captured the extent of the sharp fall, and subsequent recovery, in global growth. The three best individual indicators and a combined model are compared to the benchmark AR model for both trade and GDP.

To assess the indicators' nowcasting performance throughout the crisis, it is necessary to use only the information that would have been available at the time. In particular, the coefficients in the indicator models need to be re-estimated each quarter, extending the length of the sample period used by an extra quarter as additional data would have become available.(1) This is important because in the period immediately prior to the crisis, the correlation between the indicators and global activity was fairly low (**Chart 5**). And, as shown in the previous section, the indicators did not add much to a simple AR model in tracking world activity over the 1998–2008 period.

In the early part of the crisis, all of the indicator models outperformed the benchmark AR model. **Table B** shows that errors from real-time individual global indicator models at the third month of the quarter throughout the downturn (2008–09) were around 20%–40% smaller than those from the simple AR model for world GDP and around 30%–50% smaller for world trade. And the errors from the combined indicator were lower still. As expected, the improvement in nowcasting accuracy from using the indicators was smaller at early stages of the quarter.(2) Since the onset of the financial crisis, the nowcasts from the combined indicator model have given the best steer on global growth. Of the individual indicator models, the export orders model made the smallest errors over 2008 and 2009. Although the output PMI made larger errors over the period as a whole, it was quicker than other indicators to pick up the slowing in both world trade and world GDP growth in early 2008. The indicator fell sharply from the start of the year, and outperformed the other individual indicators in the early part of the crisis.

(1) World trade and world GDP data are frequently revised over time. So the early estimates for both of these series, which would have been available at the time the nowcasts were made, should also be used here. For simplicity, we have shown the results of models based on the latest vintage of data. But using the real-time estimates does not materially change the results.

(2) **Table B** reports nowcasting errors from the models based on information available at Month Three. Errors from the indicator models earlier in the quarter are generally larger and give less of an improvement relative to the AR benchmark. For example, at Month One, the average errors made by the individual indicator models for world GDP over the downturn are up to 30% larger than those made at Month Three. And the errors from the CPB model for trade are 50% larger than those made at Month Three.

Table B Real-time errors at Month Three from selected world GDP and world trade models[a]

	Root mean squared errors		
	2008–12	2008–09	2010–12
World GDP models			
Simple AR benchmark	0.64	0.98	0.21
Combined indicator	0.30	0.39	0.21
Export orders PMI	0.37	0.55	0.15
Output PMI	0.48	0.71	0.22
OECD CLI	0.51	0.76	0.20
World trade models			
Simple AR benchmark	2.47	3.69	1.05
Combined indicator	0.93	1.01	0.88
Export orders PMI	1.31	1.93	0.62
Output PMI	1.71	2.48	0.87
CPB goods trade	1.47	2.11	0.79

Sources: CPB Netherlands Bureau for Economic Policy Analysis, IMF, OECD, ONS, S&P indices, Thomson Reuters Datastream and Bank calculations.

(a) The root mean squared errors compare the nowcasts generated from each model to the actual world GDP and world trade outturns. The AR models are of the form: $activity_t = \alpha + \beta_1 activity_{t-1} + \beta_2 activity_{t-2}$. And the individual indicator models are of the form: $activity_t = \alpha + \beta_1 activity_{t-1} + \beta_2 indicator_t$. For more information on the combined indicator model see Appendix B. All equations are estimated using ordinary least squares and the coefficients are estimated recursively. For example, when nowcasting 2008 Q1, the coefficients in each model are estimated using data between 2000 Q1 and 2007 Q4. But when nowcasting 2008 Q2, the sample is expanded to use data from 2000 Q1 to 2008 Q1. The nowcasts are calculated at Month Three. For information on how missing monthly data are estimated, see footnote 2 on page 236.

None of the nowcasts from the indicator models fully predicted the extent of the sharp falls in world activity. In particular, they were slow to pick up the decline in world GDP, overpredicting growth throughout 2008 by an average of 0.5 percentage points per quarter. Part of the reason the nowcasts from some of the models were too high was because the weight placed on the indicators in the models only increased slowly. For example, the coefficient on the export orders PMI in the GDP model is almost twice the size if estimated using the full sample of data compared with the estimate that only uses data up to the end of 2007. It takes time for this coefficient to change when the sample period is just extended by one quarter at a time. That said, given that the downturn in the indicators followed the large financial shock in 2008, economic forecasters and policymakers may have had more reason to believe that the moves in indicators reflected genuine news about the pace of global growth.

Since the start of the recovery, the nowcasts from all the models have tracked global activity more closely than they did throughout the downturn: the average errors over the 2010–12 period were much smaller than those made in 2008 and 2009. The nowcasts from the export orders model have been the most accurate over this time, picking up the recovery and subsequent slowing in world activity growth better than the other models.

Conclusions

Several global indicators contain information that can be informative when tracking the pace of global growth. The signal from these indicators can help policymakers to monitor global growth developments in real time. Their usefulness has fluctuated greatly over time, though. Between 1999 and 2007, when global growth was fairly stable, the indicators did not contain much more information than a simple AR model. But when there are larger swings in the data the indicators tend to have a higher correlation with global activity. That was especially true during the sharp fall and recovery in global growth in 2008–09.

On average, since 2008, the most accurate nowcasts were produced by combining the signal from a range of indicators. The nowcasts from the combined indicator models tracked the sharp fall and recovery in global growth through 2008 and 2009 much more closely than those from the simple benchmark or any of the individual indicator models. Since 2010, however, the estimates from the export orders models for both world GDP and world trade have tracked quarterly growth particularly closely. And the nowcasts that just use this one indicator have given the smallest nowcast errors.

Appendix A
Description of the global indicators

Indicator	Frequency	Start year	Availability	Additional information
Direct indicators				
CPB world goods trade	Monthly	1991	Seven weeks after month end	A monthly estimate of the global volume of goods traded. The series is based on data from 96 individual countries and the region Sub-Saharan Africa, covering approximately 99% of world trade in goods.
JPMorgan global composite PMI — output index	Monthly	1998	Shortly after month end	A qualitative survey of manufacturing and services firms in 32 countries. Firms are asked whether their output has increased or decreased over the past month.
JPMorgan global manufacturing PMI — export orders index	Monthly	1998	Shortly after month end	A qualitative survey of manufacturing firms in 32 countries. Firms are asked whether their export orders have increased or decreased over the past month.
OECD composite leading indicator	Monthly	1970	Six weeks after month end	An indicator produced by the OECD that is designed to anticipate turning points in economic activity relative to trend. The index used here covers the OECD and six major non-OECD countries (Brazil, China, India, Indonesia, Russia and South Africa).
IFO *World Economic Climate* survey — headline index	Quarterly	1990	Half way through the quarter	A qualitative survey of economists from over 100 countries. They are asked whether their country's economic situation is good, satisfactory or poor and whether the next six months are likely to be more or less favourable. The headline index averages the response to these two questions.
Indirect indicators				
Baltic Dry Index	Daily	1985	Following day	An estimate produced daily by the Baltic Exchange that measures the price of moving raw materials by sea. The index covers 20 shipping routes.
Brent oil price	Daily	1983	Following day	Daily data of the closing spot price for Dated Brent crude.
S&P GSCI agricultural and livestock price index	Daily	1970	Following day	Daily index of agricultural and livestock spot prices. The index includes: wheat, corn, soybeans, sugar, coffee, cotton, cocoa, feeder cattle, live cattle and lean hogs.
S&P GSCI industrial metals price index	Daily	1977	Following day	Daily index of industrial metals spot prices. The index includes: aluminium, copper, lead, nickel and zinc.
S&P global 1200 stock price index	Daily	1989	Following day	An index of global equity prices that covers firms from 30 countries and approximately 70% of global stock market capitalisation.
IATA — international air freight tonne kilometres	Monthly	1997	Four weeks after month end	The volume of air freight transported internationally each month.
Suez Canal traffic — tons	Monthly	2000	Around two weeks after month end	The volume of goods passing through the Suez Canal each month, measured in tons.

Appendix B
Combined indicator models

This appendix sets out how the combined indicator models for world GDP and trade were constructed.

There are several ways to make use of the information contained in a range of indicators. One way is to use a regression to select the weights placed on each indicator to give the combination of indicators that has the best fit with activity over the past. This can be done by regressing world GDP and world trade on the fitted values from the different indicator models, removing any that do not add value in explaining activity.(1) This approach will select the combination of indicators that does the best job of explaining global growth over time. Separate equations can be estimated at different stages of the data cycle, allowing for the weights on different indicators to change as more data become available over the quarter.(2)

An alternative approach is to use a dynamic factor model. These models use statistical techniques to extract information from a very large set of data and map this into activity. The nowcasts from such models have generally been found to outperform the simple regression models described above. But there is evidence that the dynamic models have struggled to predict growth when there are large swings in the data, which is arguably when nowcasting is most important.(3) And they are not particularly appropriate here, as the number of variables considered is relatively small.(4) Given this, only the regression approach is used here to create a combined indicator model.

Estimating the model

To estimate the combined model, the first step was to map each of the individual indicators shown in **Table A** to world GDP and trade growth by estimating equations of the form:

$$GDP_t = \alpha + \beta \text{ indicator}_t + \text{error}_t \quad (1)$$

$$Trade_t = \alpha + \beta \text{ indicator}_t + \text{error}_t \quad (2)$$

Quarterly averages of the full set of data for the indicators were used to estimate the coefficients using ordinary least squares. These coefficients were then used to construct fitted values for world GDP and world trade. Three different sets of fitted values were calculated for world GDP and world trade growth based on the sets of indicators that would be available at the Month One, Month Two and Month Three stages of the quarter (**Figure 1**). These sets of indicators use only the monthly data that would actually be available at that point in time together with forecasts for any missing months.(5)

The estimates from the indicator models were then combined by regressing world GDP and world trade growth on these fitted values, dropping any indicators that were not significant. These models were estimated for the three different stages in the data cycle.

Charts 6 and **7** in the main article show the in-sample fit of the combined indicators for world GDP and trade. In the world GDP model, the fitted values based on the PMI export orders index, the OECD composite leading indicator and metals prices are significant. A similar weight is placed on each, although those weights do fluctuate from the first to third month models. For trade, the Month Three version of the model suggests weight should be placed on the fitted values based on the export orders PMI, output PMI and CPB data. But earlier in the quarter, a greater range of indicators are helpful: at Month One, the IATA air freight data and Brent crude oil price are also found to be significant.

The equations were estimated over the period 1998 Q3 to 2012 Q4. The coefficients from the Month One, Month Two and Month Three models are shown below.

World GDP

Month One model:

$$GDP_t = -0.26 + 0.37 \times fitted_t^{\text{export orders PMI}} + 0.50 \times fitted_t^{\text{OECD CLI}} + 0.46 \times fitted_t^{\text{metals prices}}$$

Month Two model:

$$GDP_t = -0.25 + 0.43 \times fitted_t^{\text{export orders PMI}} + 0.41 \times fitted_t^{\text{OECD CLI}} + 0.45 \times fitted_t^{\text{metals prices}}$$

Month Three model:

$$GDP_t = -0.22 + 0.49 \times fitted_t^{\text{export orders PMI}} + 0.38 \times fitted_t^{\text{OECD CLI}} + 0.39 \times fitted_t^{\text{metals prices}}$$

World trade

Month One model:

$$Trade_t = -1.55 + 0.35 \times fitted_t^{\text{export orders PMI}} + 0.28 \times fitted_t^{\text{output PMI}} + 0.78 \times fitted_t^{\text{IATA}} + 0.41 \times fitted_t^{\text{Brent price}} + 0.73 \times fitted_t^{\text{CPB}}$$

(1) See Barnes and Ellis (2005).
(2) This approach gives the same results that would be generated by simply regressing world activity variables on the raw data for the indicators at different stages in the quarter. But by mapping the indicators to world activity first, the coefficients can be interpreted as weights, allowing for an easy comparison of which indicators the models attach the most importance to.
(3) Lombardi and Maier (2011) estimate a dynamic factor model of growth for the euro area. They find that the nowcasts from the model were less informative than those from a simple PMI model through the recession. Their work suggests that the PMI model tends to perform better when there are very rapid changes to the outlook. The nowcasts from these change quickly when there is a downturn, whereas the dynamic factor model can be slower to adjust.
(4) Dynamic factor models typically run off many variables (potentially hundreds) whereas only twelve indicators are considered here.
(5) See footnote 2 on page 236 for more information.

Month Two model:

$$Trade_t = -0.63 + 0.30 \times fitted_t^{export\ orders\ PMI} + 0.38 \times fitted_t^{output\ PMI} + 0.47 \times fitted_t^{IATA} + 0.46 \times fitted_t^{CPB}$$

Month Three model:

$$Trade_t = -0.44 + 0.25 \times fitted_t^{export\ orders\ PMI} + 0.51 \times fitted_t^{output\ PMI} + 0.56 \times fitted_t^{CPB}$$

Where $fitted_t^{indicator} = \alpha + \beta\ \text{indicator}_t$ are the fitted values from the individual indicator models (equations **(1)** and **(2)**).

When estimating the nowcasts in **Table B**, the coefficients are updated recursively, adding an extra quarter to the sample period as more data become available. So the estimates of the coefficients gradually change over time.

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